CLAIMS

1. A gait generating system for a mobile body, the system determining a gait parameter, which is composed of a set of a plurality of parameters defining a gait of a mobile robot in a predetermined period, and generating a desired gait of the mobile robot in the predetermined period by using the determined gait parameter and a dynamic model of the mobile robot, comprising:

n (n: an integer of 2 or more) dynamic models that include a motion/floor reaction force model representing a relationship between motions of the mobile robot and the floor reaction forces acting on the robot and that are constructed such that at least one of the motion/floor reaction force model, a restrictive condition added to a motion of the mobile robot in the motion/floor reaction force model, and a restrictive condition added to a floor reaction force in the motion/floor reaction force model is different from each other;

a first gait parameter determining means for determining a first gait parameter, which is composed of a set of provisional values of the plurality of parameters, such that a gait in the predetermined period that is generated using the first gait parameter and a first dynamic model, which is a predetermined dynamic model among the n dynamic models, satisfies a predetermined boundary condition; and

a gait parameter correcting means for determining an

m-th gait parameter, which is a gait parameter obtained by correcting a predetermined parameter to be corrected out of an (m-1)th gait parameter, from a second gait parameter to an n-th gait parameter in order by using an m-th dynamic model (m: integer satisfying $2 \le m \le n$), wherein each of n-1 dynamic models excluding the first dynamic model among the n dynamic models is defined as the m-th dynamic model,

wherein the gait parameter correcting means comprises a means for determining the m-th gait parameter by, when the m-th gait parameter is respectively determined, generating a gait in the predetermined period by using the (m-1)th gait parameter and the m-th dynamic model and by correcting the parameter to be corrected out of the (m-1)th gait parameter such that the degree of deviation after correction, which is the degree of deviation of a gait in the predetermined period that is generated using the m-th gait parameter and the m-th dynamic model from the predetermined boundary condition is smaller than the degree of deviation before correction or the degree of deviation after correction falls within a predetermined degree of deviation permissible range on the basis of at least the degree of deviation before correction, which is the degree of deviation of the generated gait from the predetermined boundary condition, and

a desired gait in the predetermined period is

generated using an n-th gait parameter out of the determined m-th gait parameter and an n-th dynamic model.

2. A gait generating system for a mobile robot, when generating a desired gait of a mobile robot in a predetermined period, the system determining a normal gait parameter, which is composed of a set of a plurality of parameters defining a normal gait, which is a virtual cyclic gait following the desired gait, and generating the desired gait such that the desired gait approximates a normal gait generated using the determined normal gait parameter and a predetermined dynamic model of the mobile robot, comprising:

n (n: an integer of 2 or more) dynamic models that include a motion/floor reaction force model representing a relationship between motions of the mobile robot and the floor reaction forces acting on the robot and that are constructed such that at least one of the motion/floor reaction force model, a restrictive condition added to a motion of the mobile robot in the motion/floor reaction force model, and a restrictive condition added to a floor reaction force in the motion/floor reaction force model is different from each other;

a first normal gait parameter determining means for determining a first normal gait parameter, which is formed of a set of provisional values of the plurality of parameters, such that a normal gait generated using the

first normal gait parameter and a first dynamic model, which is a predetermined dynamic model among the n dynamic models, satisfies a predetermined boundary condition; and

a normal gait parameter correcting means for determining an m-th normal gait parameter, which is a normal gait parameter obtained by correcting a predetermined parameter to be corrected out of an (m-1)th normal gait parameter, from a second normal gait parameter to an n-th normal gait parameter in order by using an m-th dynamic model (m: integer satisfying $2 \leq m \leq n$), wherein each of n-1 dynamic models excluding the first dynamic model among the n dynamic models is defined as the m-th dynamic model,

wherein the normal gait parameter correcting means comprises a means for determining, when the m-th normal gait parameter is determined, the m-th normal gait parameter by generating gaits for a period of at least one cycle of the normal gait by using the (m-1)th normal gait parameter and the m-th dynamic model and by correcting the parameter to be corrected out of the (m-1)th normal gait parameter on the basis of at least the degree of deviation before correction, which is the degree of deviation of the generated gait from the predetermined boundary condition, such that the degree of deviation after correction, which is the degree of deviation of a gait generated using the m-th normal gait parameter and the m-th dynamic model from the predetermined boundary condition, is smaller than the

degree of deviation before correction or the degree of deviation after correction falls within a predetermined permissible range of the degree of deviation, and

a desired gait in the predetermined period is generated such that the desired gait approximates a normal gait generated using an n-th normal gait parameter out of the determined m-th normal gait parameter and an n-th dynamic model.

3. The gait generating system for a mobile robot according to Claim 1, wherein the n dynamic models are constructed such that the linearity between the degree of deviation of a gait generated using an arbitrary gait parameter and the (m-1)th dynamic model from the predetermined boundary condition and the parameter to be corrected out of the gait parameter is higher than the linearity between the degree of deviation of a gait generated using the gait parameter and the m-th dynamic model from the predetermined boundary condition and the parameter to be corrected out of the gait parameter.

4. The gait generating system for a mobile robot according to Claim 2, wherein the n dynamic models are constructed such that the linearity between the degree of deviation of a normal gait generated using an arbitrary normal gait parameter and the (m-1)th dynamic model from the predetermined boundary condition and the parameter to

be corrected out of the normal gait parameter is higher than the linearity between the degree of deviation of a normal gait generated using the normal gait parameter and the m-th dynamic model from the predetermined boundary condition and the parameter to be corrected out of the gait parameter.

5. The gait generating system for a mobile robot according to Claim 1, wherein the n dynamic models are constructed such that the calculation time for generating a gait in the predetermined period by a computer by using an arbitrary gait parameter and the (m-1)th dynamic model is shorter than the calculation time for generating a gait in the predetermined period by the computer by using the gait parameter and the m-th dynamic model.

6. The gait generating system for a mobile robot according to Claim 2, wherein the n dynamic models are constructed such that the calculation time for generating a gait in the one-cycle period of the normal gait by a computer by using an arbitrary normal gait parameter and the (m-1)th dynamic model is shorter than the calculation time for generating a gait in the one-cycle period of the normal gait by the computer by using the gait parameter and the m-th dynamic model.

7. The gait generating system for a mobile robot

according to Claim 1 or 2, wherein the mobile robot is a legged mobile robot, and

at least the first dynamic model and a second dynamic model out of the n dynamic models are constructed such that the ratio of the mass of the legs of the robot to the total mass of the mobile robot in the first dynamic model is smaller than the ratio of the mass of the legs of the robot to the total mass of the mobile robot in the second dynamic model.

8. The gait generating system for a mobile robot according to Claim 1, wherein if one predetermined dynamic model out of the n dynamic models, excluding the n-th dynamic model, is denoted as a k-th dynamic model (k: any integer that satisfies $1 \le k \le n-1$), then at least the k-th dynamic model and a (k+1)th dynamic model are dynamic models, respectively, to which a condition in which at least one of a motion of the mobile robot and a floor reaction force in a gait generated using the dynamic models and arbitrary gait parameters falls within the predetermined permissible ranges set for the individual dynamic models is added as the restrictive condition, and a permissible range used with the (k+1)th dynamic model is set to be narrower than a permissible range used with the k-th dynamic model.

9. The gait generating system for a mobile robot

according to Claim 2, wherein if one predetermined dynamic model out of the n dynamic models, excluding the n-th dynamic model, is denoted as a k-th dynamic model (k: any integer that satisfies $1 \leq k \leq n-1$), then at least the k-th dynamic model and a (k+1)th dynamic model are dynamic models, respectively, to which a condition in which at least one of a motion of the mobile robot and a floor reaction force in a normal gait generated using the dynamic models and arbitrary normal gait parameters falls within the predetermined permissible ranges set for the individual dynamic models is added as the restrictive condition, and the permissible range used with the (k+1)th dynamic model is set to be narrower than the permissible range used with the k-th dynamic model.

10. The gait generating system for a mobile robot according to Claim 1 or 2, wherein if a predetermined motion/floor reaction force model representing a relationship between motions of the mobile robot and floor reaction forces is defined as an A-th motion/floor reaction force model, a predetermined motion/floor reaction force model that represents a relationship between the motions of the mobile robot and floor reaction forces and the relationship is constructed such that the floor reaction forces generated in response to predetermined motions of the robot are different from those of the A-th motion/floor reaction force model is

defined as a B-th motion/floor reaction force model, and one predetermined dynamic model out of the n dynamic models, excluding the n-th dynamic model, is defined as a k-th dynamic model (k: any integer that satisfies $1 \leq k \leq n-1$), then the k-th dynamic model will be a dynamic model in which the floor reaction force generated on the k-th dynamic model in response to an arbitrary motion of the mobile robot takes a weighted mean value calculated using a predetermined weight from a floor reaction force generated on the A-th motion/floor reaction force model in response to the motion and a floor reaction force generated on the B-th motion/floor reaction force model in response to the motion, and the (k+1)th dynamic model will be a dynamic model in which the floor reaction force generated on the k-th dynamic model in response to an arbitrary motion of the mobile robot takes a weighted mean value calculated using a predetermined weight different from that in the k-th dynamic model from a floor reaction force generated on the A-th motion/floor reaction force model in response to the motion and a floor reaction force generated on the B-th motion/floor reaction force model in response to the motion.

11. The gait generating system for a mobile robot according to Claim 1, wherein the gait parameter includes a parameter specifying a desired ZMP trajectory in the gait during the predetermined period as the parameter to

be corrected.

12. The gait generating system for a mobile robot according to Claim 2, wherein the normal gait parameter includes a parameter that specifies a predetermined state amount of a motion of the mobile robot at one end of the one-cycle period of the normal gait as the parameter to be corrected.

13. The gait generating system for a mobile robot according to Claim 1, wherein the predetermined boundary condition includes a condition in which a predetermined state amount of a motion of the mobile robot in a boundary of a gait during the predetermined period agrees with the predetermined state amount of the motion of the mobile robot in an adjacent gait in the boundary.

14. The gait generating system for a mobile robot according to Claim 1, wherein the predetermined boundary condition includes a condition in which the predetermined state amount of a motion of a mobile robot in the boundary of at the terminating end of a gait in the predetermined period agrees with the predetermined state amount of a motion of the mobile robot in a normal gait determined as the virtual cyclic gait that is to follow the gait.

15. The gait generating system for a mobile robot

according to Claim 2, wherein the predetermined boundary condition includes a condition in which the predetermined state amounts of a motion of a mobile robot at the starting end and the terminating end of one cycle of the normal gait agree with each other.

16. The gait generating system for a mobile robot according to any one of Claims 12 to 15, wherein the mobile robot is a legged mobile robot equipped with a plurality of legs extended from its body, and the predetermined state amount includes at least one of the position of the body of the robot, the velocity of the body, the posture angle of the body, the angular velocity of the posture angle of the body, the weighted mean values of the position and the velocity of the body, the position of the total center-of-gravity of the robot, the velocity of the total center-of-gravity of the robot, the weighted mean values of the position and the velocity of the total center-of-gravity, and a divergence component.

17. The gait generating system for a mobile robot according to Claim 1, wherein the gait parameter correcting means is a means that, when determining each of the m-th gait parameters, generates a gait in the predetermined period by using the (m-1)th gait parameter and the m-th dynamic model, determines at least one set of auxiliary gait parameters obtained by correcting the

parameter to be corrected out of the (m-1)th gait parameter by a predetermined amount, generates a gait in the predetermined period by using the determined auxiliary gait parameter of each set and the m-th dynamic model, determines the correction amount of the parameter to be corrected out of the (m-1)th gait parameter on the basis of the degree of deviation before correction, which is the degree of deviation of the gait, which has been generated using the (m-1)th gait parameter, from the predetermined boundary condition and the auxiliary degree of deviation of the gait, which has been generated using the auxiliary gait parameters of each set, from the predetermined boundary condition, and corrects the parameter to be corrected, thereby determining the m-th gait parameter.

18. The gait generating system for a mobile robot according to Claim 2, wherein the normal gait parameter correcting means is a means that, when determining each of the m-th normal gait parameters, generates a gait for at least one-cycle period of the normal gait by using the (m-1)th normal gait parameter and the m-th dynamic model, determines at least one set of auxiliary normal gait parameters obtained by correcting the parameter to be corrected out of the (m-1)th gait parameter by a predetermined amount, generates a gait for at least the one-cycle period of the normal gait by using the determined auxiliary normal gait parameters of each set

and the m-th dynamic model, determines the correction amount of the parameter to be corrected out of the (m-1)th normal gait parameter on the basis of the degree of deviation before correction, which is the degree of deviation of the gait, which has been generated using the (m-1)th normal gait parameter, from the predetermined boundary condition and the auxiliary degree of deviation, which is the degree of deviation of a gait generated using the auxiliary normal gait parameters of each set from the predetermined boundary condition, and determines the m-th normal gait parameter by correcting the parameter to be corrected.